**RDECOM**



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

# Analysis of Modeling and Simulation to Support Test and Evaluation of Chemical and Biological Defense Systems

**George E. Steiger, PhD**

**06/10/2008**

Approved for PUBLIC RELEASE; Distribution is UNLIMITED

| | | Form Approved OMB No. 0704-0188 |
|---|---|---|

**Report Documentation Page**

| 1. REPORT DATE **01 JUN 2008** | 2. REPORT TYPE **N/A** | 3. DATES COVERED **-** |
|---|---|---|

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **Analysis of Modeling and Simulation to Support Test and Evaluation of Chemical and Biological Defense Systems** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **RDECOM** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release, distribution unlimited**

13. SUPPLEMENTARY NOTES
**See also ADM202527. Military Operations Research Society Symposium (76th) Held in New London, Connecticut on June 10-12, 2008, The original document contains color images.**

14. ABSTRACT

15. SUBJECT TERMS

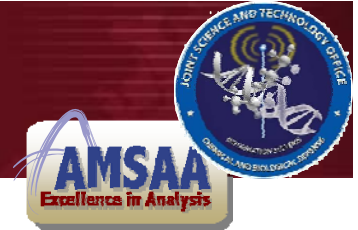| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT **unclassified** | b. ABSTRACT **unclassified** | c. THIS PAGE **unclassified** | **UU** | **14** | |

- Provide an overview of AMSAA study results of modeling and simulation (M&S) to support test and evaluation (T&E) chemical biological defense (CBD) systems

- Present top-level results, conclusions, and recommendations

- Determine M&S needs to support T&E of Chemical and Biological Defense (CBD) systems in an operational context; identify M&S capability gaps
- Develop strategic recommendations
- Examine feasibility of an integrated CBD M&S capability for T&E
- Scope
    - CBD commodity areas considered:



- M&S areas considered
    - System performance
    - Operational effectiveness
    - System of Systems
    - Ancillary/supporting models and databases

*Study sponsored by Defense Threat Reduction Agency (DTRA)/ Joint Science and Technology Office (JSTO)*

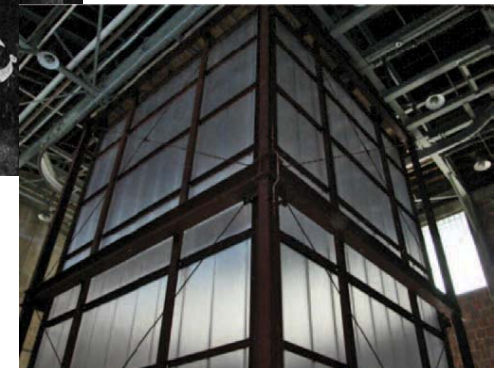**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

- General community consensus for the need to develop/mature CBD Modeling and Simulation capability to support T&E

- Technical and programmatic approach not well defined; basis for future POM effort needed

*"What are the community needs in terms of M&S support to T&E models to support evaluation in an operational context"*

- Can't use "live" agents in operational tests
- Need to bridge gap from component testing to system-level performance
- Difficult to translate system performance to "operational effectiveness"
- Whole system testing currently impractical
- CB testing is expensive
- Range of CB agent physical properties extensive
- Need to consider TICs, TIMs, NTAs
- Limited "library" of actual "effects"

*TECHNOLOGY DRIVEN. **WARFIGHTER FOCUSED.***

## Input

- Identify users and stakeholders
- Visit and interview potential user and stakeholder organizations

↓

## Process

- Define user and stakeholder needs, existing capabilities, and gaps
- Refine requirements
- Translate to high level technical requirements

↓

## Output

- T&E M&S needs
- Feasibility of current T&E M&S approaches
- T&E M&S gaps
- T&E M&S requirements
- Strategic recommendations; Path forward

- Stakeholder organization interviews:
  - DTRA/JSTO, TEMA, DOT&E
  - JPEO-CBD, JPMs (BD, NBC-CA, CP, Decon, IP, IS, Guardian), PD-TESS
  - ATEC, DTC, AEC, MCOTEA, AFOTEC, OPTEVFOR, ECBC, WDTC

- T&E IPT participation:
  - TECMIPT, OSD CB M&S IPT, T&D IPT AUSCANUKUS, JECP Test WIPT, JPM-IS Working Group, RDECOM M&S IPT
  - Use IPTs to facilitate community review

*TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.*

- What are your CB T&E M&S needs?
- What CB T&E M&S system(s) are you currently using to meet your needs?
- What are the capabilities of the CB T&E M&S system(s) you are using?
- What are the limitations of the systems that you are using relative to your CB T&E M&S needs?
- What CB T&E M&S system capabilities/resources do you require that are not available or that are inadequate?
- Are you developing any CB T&E M&S systems or are there systems that you recommend be developed?
- Who provides the data/information for use in the T&S M&S models that you use?
- Who uses the products of your CB T&E M&S efforts?
- What organizations should participate in a CB T&E M&S review group?
- How much do you know about CBD T&E models under development?

*Questions presented during CBD T&E community interviews to generate discussion*

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

- Prediction of system-level performance:
  - From component test data (e.g., swatch, coupon)
  - Under conditions that cannot be currently tested
    - Greater range of conditions (weather, terrain, background, interferences)
    - Open-air live agents (agent-to-simulant correlation/improved simulants)
    - Use of NTAs, TICs/TIMs (agent-to-simulant correlation)
- Translate systems performance into quantitative measures of operational effectiveness – Impact of system(s) on force
- Prediction of operational effective of CBD system of systems (i.e., commodity area systems working together)
- Test planning tools (test design, post-test support, scope development)
- Incremental capability improvement – interim solutions
- Common CB threat scenarios
- Reference data, standards for data, model architectures
- High fidelity Transport and Dispersion models

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

- **System performance**
  - Limited capability to predict system performance
    - Current Contamination Avoidance models are first-order, physics-based models and have limited T&E application
    - Other model efforts (Decon, ColPro, IP) are in early stages and face significant technical challenges and data gaps
  - Methods to translate component data to system effects are first-order estimates

- **Operational effectiveness**
  - Limited CB effects in Army force-on-force combat simulations
  - Limited capability to support T&E; limited to qualitative assessments
    - Recent CB effects modifications to IWARS demonstrated potential to quantify operational effects; Used by AEC for JCAD system evaluation
  - No capability to assess the operational effectiveness of CBD system of systems

- **Ancillary models/databases**
  - Weather, terrain models mature
  - Existing supporting models/databases with varying degree of robustness
  - Toxicological exposure and effects models exist but lack community consensus
  - Threat scenarios used are program specific – not common between programs
  - T&D models lack fidelity to support T&E

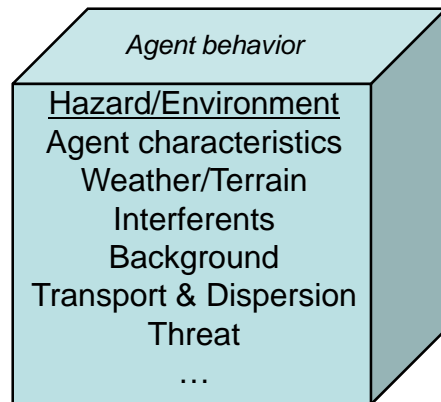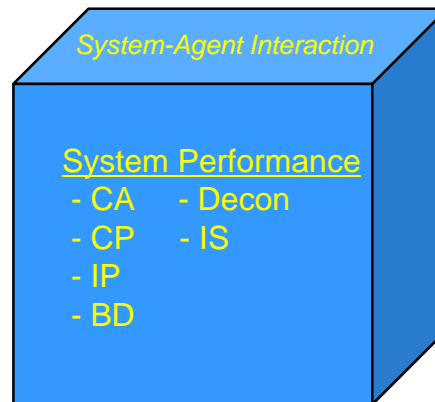*TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.*

- **Concept:** An overarching model comprised of underlying physics-based and/or empirical, commodity area T&E models, ancillary models (Weather, Transport and Diffusion, Terrain, combat simulations, others), and databases (toxicology, background, interferences, others) intended to provide materiel item operational performance assessment

- **Users:** T&E community (developmental and operational), combat developers, materiel developers, and warfighters

- **Technical Challenges:**
  - Requires commodity area system performance models
  - Current commodity area approaches at varying levels of maturity
  - Underlying system models require sufficient V&V; current system DT efforts may not provide enough underlying data for adequate V&V
  - Current model architectures not designed for future integration across all commodity areas
  - Integration of CBD effect modeling capability with current combat simulations in early stages
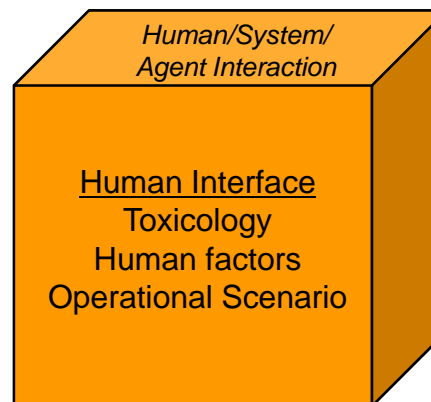  - Integration of system performance models and operational effectiveness models

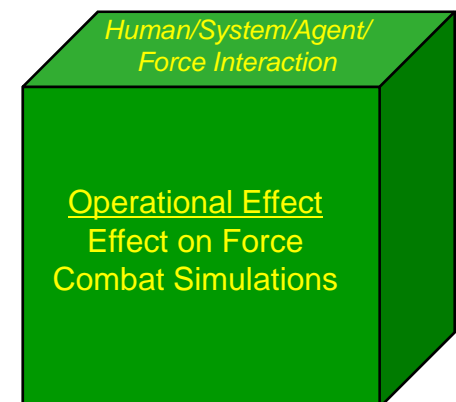  *ISF concept could potentially address many T&E M&S needs*

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

**Agent behavior**

Hazard/Environment
Agent characteristics
Weather/Terrain
Interferents
Background
Transport & Dispersion
Threat
…

Ancillary/supporting
models/databases

**System-Agent Interaction**

System Performance
- CA      - Decon
- CP      - IS
- IP
- BD

Prediction of System
Performance in the
synthetic environment

**Human/System/
Agent Interaction**

Human Interface
Toxicology
Human factors
Operational Scenario

Ability to assess effect
of human interaction
with system and agent

**Human/System/Agent/
Force Interaction**

Operational Effect
Effect on Force
Combat Simulations

Assess effect of the
CBD system, or system
of systems ,on an
operational force
conducting its mission
under a specified
scenario of interest
(environment, threat,
etc.)

Hazard/Enviro
Characteristics

Systems
Performance

Human Factors/
Characteristics

Combat
Simulations

*Human-Agent-System-Force interaction =
Operational Effectiveness*

*TECHNOLOGY DRIVEN.* **WARFIGHTER FOCUSED.**

Synthetic Environment

- Physics/Structure Models
- Stimulators
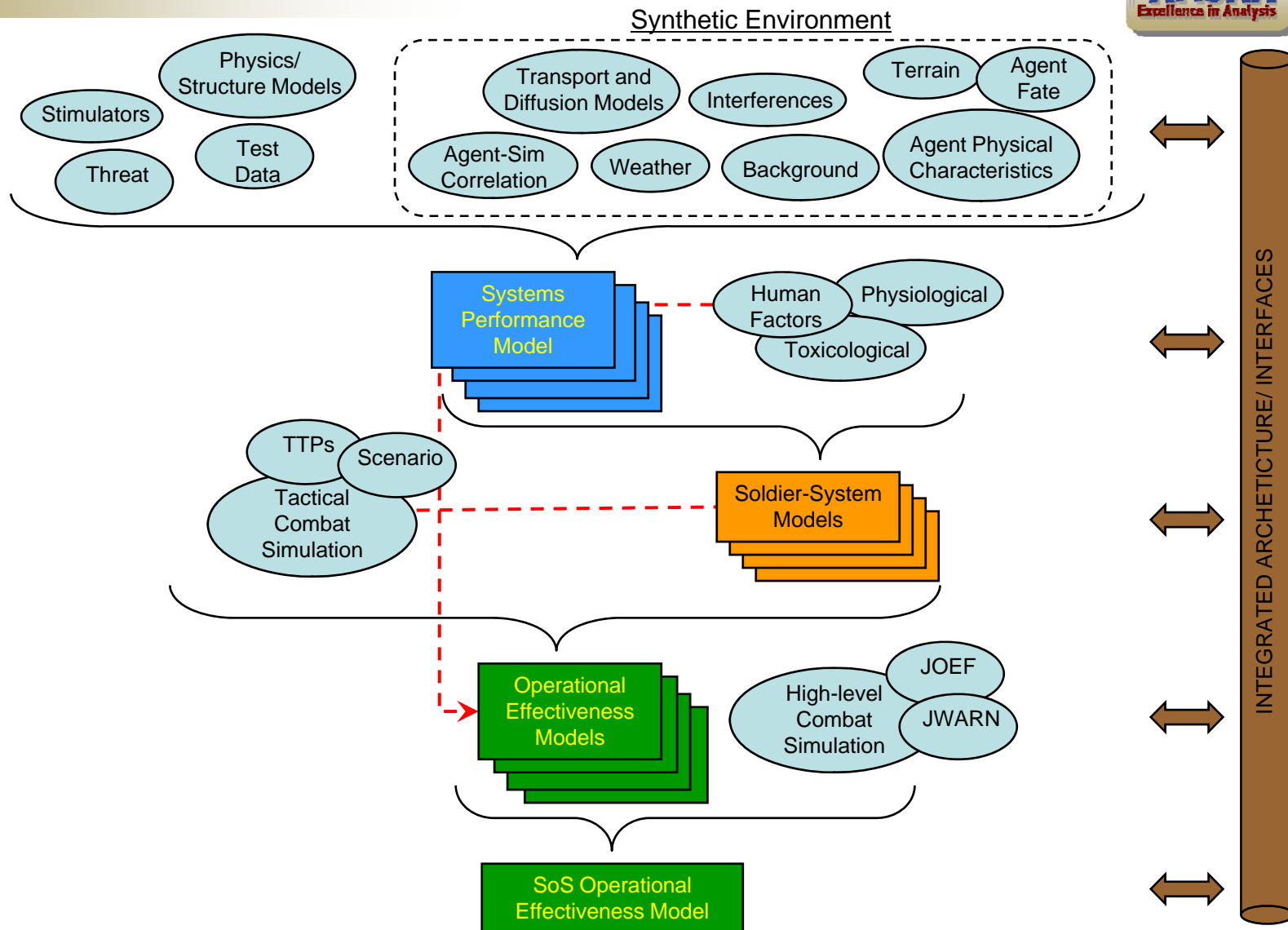- Threat
- Test Data
- Transport and Diffusion Models
- Interferences
- Terrain
- Agent Fate
- Agent-Sim Correlation
- Weather
- Background
- Agent Physical Characteristics

Systems Performance Model
- Human Factors
- Physiological
- Toxicological

- TTPs
- Scenario
- Tactical Combat Simulation

Soldier-System Models

Operational Effectiveness Models
- High-level Combat Simulation
- JOEF
- JWARN

SoS Operational Effectiveness Model

INTEGRATED ARCHETICTURE/ INTERFACES

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

# Questions?

Points of Contact:

Carl Eissner
*carl.eissner@us.army.mil*
*410-278-6389, DSN 298-6389*

George Steiger, PhD
*george.steiger@us.army.mil*
*410-278-6442, DSN 298-6442*

*US Army Materiel Systems Analysis Activity*
*ATTN: AMSRD-AMS-SD*
*Aberdeen Proving Ground, Maryland 21005*

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

| | |
|---|---|
| POM | Program Objective Memorandum |
| TIC | Toxic Industrial Chemical |
| TIM | Toxic Industrial Material |
| NTA | non-traditional agent |
| IPT | Integrated Product Team |
| V&V | Verification and Validation |
| DT | Developmental Testing |
| ISF | Integrated Simulation Framework |

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**